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## Dissertation

**Title** *Control Strategies for Improving the Performance of Heaving Wave Energy Converters*

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**Abstract**

The main objective of this study is to develop control strategies to enhance the performance of single-body heaving wave energy converters (WECs). Maximizing the energy captured from sea waves while respecting the physical and thermal limitations of the WEC is of a paramount importance for any control strategy to be effective. In addition, it is desirable for the controller to be less vulnerable to model uncertainties and external disturbances. A complete wave-to-wire dynamic model has been derived for the heaving WEC. This includes models that describe the system hydrodynamic forces and the power take-off mechanism. In this work, heuristic controllers that are independent of any mathematical models are introduced such as fuzzy logic-based controllers. Moreover, model-based control strategies with low computational cost and inherent robustness capabilities are also examined, such as those strategies based on model predictive controllers. Numerical simulations are carried out to validate the developed controllers using MATLAB/Simulink. The simulation results show that a good balance between optimum energy capturing and system constraints handling can be attained. The dissertation also presents preliminary work on constructing a novel 1.5 kW PMLG experimental test bed for emulating heaving WEC. The test bed is part of a hardware-in-the-loop system, where the developed controllers will be tested under different operating scenarios.



**Keywords:** Wave energy, heaving wave energy converter, power take-off, control strategy, permanent magnet linear generator


## Research Relevance and Potential Impact

This research mainly focused on proposing novel control strategies that are deployed to improve the energy capture of wave energy converters. A better control would enhance the chances for more effective operation at low to medium wave profiles, which are found in the UAE eastern territorial waters. Therefore, this project is aligned with UAE national priorities in improving sustainable energy capability of the country via generating electric power from clean renewable energy sources.

## Relevant Publications


- Jama, M.; Noura, H.; Wahyudie, A.; Assi, A. Enhancing the Performance of Heaving Wave Energy Converters Using Model-Free Control Approach. Renewable Energy 83 (2015) 931-941.
- Wahyudie, A.; Jama, M.; Saeed, O.; Assi, A.; Harib, K. Robust and Low Computational Cost Controller for Improving Captured Power in Heaving Wave Energy Converters. Renewable Energy 82 (2015) 114-124.
- Jama, M.; Wahyudie, A.; Assi, A.; Noura, H. An Intelligent Fuzzy Logic Controller for Maximum Power Capture of Point Absorbers. Energies 7 (2014) 4033-4053.


## Career Aspirations

I look forward to continue working in research that involves renewable energy and sustainable development. More specifically, I would like to further explore the application of control laws into renewable energy resources to make them more reliable and cost effective.